Volcanic Rocks of the Northern and Central Interior Highlands of Nicaragua

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Abstract

The volcanic rocks of these regions have been grouped into three major divisions by McBirney and Williams: (1) a lower section consisting mainly of volcanic sediments, laharic breccias, and a few basaltic and andesitic lavas; (2) younger andesitic and dacitic lavas and pyroclastic debris, which is referred to as the Matagalpa volcanic series; and (3) a group composed of andesitic and dacitic ignimbrites, their waterlaid equivalents, and thin sheets of basic lava. These rocks belong to an upper part of a Tertiary sequence, the Matagalpa series, that laps northward onto a structural high.

There is some similarity between these rocks and the rocks found in the Late Tertiary and Quaternary volcanics in the Guatemalan Highlands and the sourthern part of El Salvador. Volcanic rocks of the Guatemala Highlands are mostly fissure extrusions with some composite cones. Volcanic rocks of El Salvador are mostly deposits of glowing avalanches and dacitic pumice. Olivine basalts and biotite-rich rhyodacites are also found in El Salvador as well as in Nicaragua.

Introduction

Literature written on the geology of Nicaragua is sparse. The amount of literature written in English is even more sparse and literature written in English on the volcanic rocks of Nicaragua is at a premium. Howell Williams and Alexander R. McBirney are two geologists who have done some geological reconnaissance of Nicaragua. It is from the papers of these two men and a few other papers that I have compiled the necessary information to prepare this paper. It is the purpose of this paper to pull together all the information available on the volcanic rocks of the northern and central Interior Highlands, explain them, and compare them somewhat to other volcanics of nearby Central American countries.

I would like to express my gratitude to Dr. John Sutter of The Ohio State University for his help and understanding in the completion of this paper.

Discussion

Nicaragua is a rather underdeveloped country by American standards and therefore lacks improved roads in most of the country. Very few roads of any kind penetrate the mountainous regions, such as the Departments of Matagalpa, Jinotega, and Nuevo Segovia in central and northern Nicaragua. In view of the dense vegetation, complex structure, and diversity of rock types, it is doubtful whether detailed studies of the areas will ever be made. Only where artificial exposures have been cut by road building or exploration is the general nature of the rock series revealed. The rocks of this region have been grouped into a composite unit which is called the Matagalpa series after the department in which it is best seen.

The Late Tertiary Matagalpa series forming the mountainous highlands of this region is composed of a wide variety of lavas, breccias, lahars, and pyroclastic beds mainly of intermediate composition. Individual units have only limited extent, and the complex structural relations suggest that eruptions took place from a belt of low coalescing cones which formed a peninsula or archipelago near the present central highlands. Autobrecciated pyroxene-andesite lavas and blocky lahars are the dominate rock types of these regions. Due to the high annual rainfall weathering of these highly porous rocks is intense. Hydro-thermal alteration has reduced these rocks to white and buff clay in many places. Platy dacite lavas, probably second only to andesites in abundance, are usually better preserved. They form thick, short amygdules filled with concentric layers of chalcedony, calcite, chlorite, zeolites, and quartz. Some plagioclase phenocrysts are pseudomorphed by calcite. The groundmass consists of oligoclase, ore, and devitrified glass. Several small mines in the district around San Ramon, about 15 kilometers southeast of Matagalpa, have produced gold and minor amounts of copper. Farther east, deformation is less intense, and although many rocks in roadcuts and streambanks are weathered, severe alteration is less common in the massive lavas.

Most of the volcanic rocks of central and northern Nicaragua were erupted on land although parts of Nicaragua were under water during Quaternary times. The Nicaraguan Depression was once a long inlet of the Caribbean. There were volcanics on both the north and south shores of the depression. There are also lacustrine and fluviatile deposits interbedded with these volcanics. Some fossils and a little evidence of organic debris was found in these beds. Such organic debris included a lacustrine flora interlayered with the andesitic volcanic series along the Rio Jicaro near the southern edge of the Central Highlands. Calcareous sediments underlying the same volcanic series a short distance to the east were found to contain Miocene or younger ostracods and foraminifera. This is consistent with a potassium-argon age of 17.2 million years obtained from similar volcanic sediments in the valley of the Rio Tuma.

East and southeast of Matagalpa, roads cross large sections of an andesite series revealing the relation of these rocks to the volcanic sediments to the east. Road cuts east of Matagalpa reveal massive andesite flows, subordinate interlayered tuffaceous sediment, and a few beds of white pumiceous hornblende and biotite-rich rhyodacite sillars. Hornblende andesite, found on the crest of the range between Matagalpa and the Rio Tuma, contained large phenocrysts and glomerocrysts of labradorite and andesine, some of which had cores of calcite. These phenocrysts comprise 15% of the rock with another 2% of the rock made up of oxyhornblend crystals with thick opaque rims. The groundmass consists mainly of andesine glass, finely disseminated ore, a small amount of clinopyroxene, and cristobalite. In the same area also found was a dense dark rock composed of small, widely scattered phenocrysts of andesine, augite, magnetite, and hematite in a groundmass of augite, andesine, ore and interstitial quartz and alkali feldspar.

Hornblende-biotite rhyodacite ignimbrites have also been found in the area. Broken phenocrysts of andesine, hornblende, brown biotite, and corroded and embayed quartz, together with angular chips of andesite and glassy basalt are set in a vitroclastic matrix of colorless devitrified glass and compressed bits of pumice. Opal and tridymite fill irregular pores.

Low on the eastern slopes of the highlands, platy pyroxene andesite and massive iddingsite-rich basalt form virtually flat-lying sheets. Andesite lava also in the area contains large euhedral phenocrysts of labradorite and andesine, many of them partly replaced by calcite, in a groundmass of oligoclase, calcite, and magnetite loaded glass. On the road near Amort, platy andesite lava with a third made up of calcic labradorite phenocrysts with inclusions of glass and clino-pyroxene was found. The coarse intergranular groundmass contains about 70% calcic andesine and 30% augite and a little pigeonite. Accessory magnetite and green clay are disseminated throughout. Tuffaceous interbeds are relatively rare in this section until the road approaches the slopes above the Rio Tuma where one passes into well bedded tuffaceous sediments and volcanic breccias. On the banks of the river tuffaceous sediments are rich in bituminous organic matter but no fossils have been found.

Ascending the northeast slopes one passes again into flat-lying flows of iddingsite basalt and pyroxene andesite and a few sheets of ignimbrite, which, together with associated flows of olivine basalt appear to overlie the volcanic sediments for many kilometers farther to the northeast. The iddingsite basalt contains phenocrysts of medium labradorite with oligoclase rims, and lesser amounts of diopside augite and rare hypersthene scattered through an intergranular groundmass of labradorite, augite, iddingsite, ore, and hematite. A few xenocrysts of orthoclase and quartz were found in advanced stages of alteration and resorption.

About 1.5 kilometers east of the Rio Tuma on these same northeast slopes more pyroxene andesite lava is found. Phenocrysts of euhedral labradorite, and rare augite and hypersthene make up about 5% of the rock. The groundmass consists of oligoclase, clinopyroxene, magnetite, hematite, and devitrified glass.

A similar Tertiary sequence is exposed along the road from Matagalpa to

Muy Muy. Approaching the Rio Grande de Matagalpa, one passes abruptly from andesitic lavas, lahars, and volcanic sediments into an underlying series of silty shales and clay-rich sand. Beautiful exposures of this sedimentary sequence can be seen in cliffs near the river ford at Loma Zanzibar a short distance west of Muy Muy. There, bright green and gray thin bedded fluviatile sediments are interlayered with white beds of reworked pumice lapilli and waterlaid ignimbrites. There were some fossil woods and plants but none preserved well enough to be used in dating the beds. The base of this sedimentary series is not exposed but a total thickness of 200 meters is not an unreasonable approximation.

Immediately to the east of the town of Muy Muy, a prominent ridge, about 100 meters high, encloses an oval depression measuring 4 kilometers in an east-west direction and 2.5 kilometers north-south. As seen from the air or on topographic maps, this conspicuous ridge resembles a ring dike. It is actually the rim of a massive stock (see geologic map for location). The stock consists of a coarsely crystalline olivine-augite basalt. There is no upturning or thermal alteration of the fluviatile sediments and waterlaid ignimbrites adjacent to the rim, but since the basalt has a chilled glassy margin and no detritus from the basalt is present in the surrounding sediments, it must be an intrusive body. Coarse-grained rocks within the intrusion have weathered more rapidly than the fine-grained margins, so that the latter now forms a ridge around a low interior. Offset of the ridge at the west and east sides and a difference in the topography of the northern and southern parts of the depression suggest that the intrusion has been cut by an east-west, left lateral fault along which there might possibly have been some vertical movement as well. Rocks from the interior of the stock consist of coarse bytownite, augite, olivine, magnetite, and about 20% interstitial glass that contains clusters of hollow oligoclase prisms.

Augite andesites or andesitic basalts are the most common rocks of this region. From the western margin of the Muy Muy stock were found coarsely crystalline basalt porphyries. Thick laths of sodic bytownite showing oscillatory zoning and rims of more sodic plagioclase make up nearly half of the rock. A quarter of the rock is composed of augite which encloses small plagioclase laths. Olivine, partly altered to iddingsite, and magnetite account for about 10% of the rock and the remainder consists of interstitial oligoclase, ore, devitrified brown glass, and goethite. Other rocks from the same locality are essentially the same with minor differences in crystal size and mineral abundance.

From the northwest margin of the Muy Muy stock, coarsely crystalline basalt porphyry differs from the other specimens in having much less glass. Large phenocrysts of sodic bytownite are enclosed in a medium-grained diabasic groundmass consisting of medium labradorite, augite, and olivine.

Nearly all the rocks show advanced alteration of the ferromagnesian minerals to chlorite, epidote, and magnetite with calcite a common accessory.

Several disconnected limestone bodies are present within the volcanic series north and east of the Cordillera Isabela (consult geologic map for location). Two of these bodies examined near the Rosita copper deposits were found to be silicified and apparently barren of fossils. They may be equivalent to Albian limestones of the Metapan formation found along the Rios Coco and Bocay on the opposite side of the range, but they are found within a weakly metamorphosed volcanic series unlike any of the Metapan rocks and may be older. Several small limestone bodies exposed in the course of recent mineral exploration near Rosita have been converted to garnet-skarns by intrusion of stocks of monzonite and granite. In their mineral character and geologic setting these mineralized skarns resemble those found in mines near Metapan in El Salvador.

The geology along parts of the Rio Coco and several of its tributaries reveals the volcanic series there rests on sandy shale, conglomerate, and limestone of the Cretaceous Metapan formation, but lavas do not seem to occur within the sedimentary section. Therefore it can be hypothesized that pre-Tertiary volcanism did not extend north of the present Cordillera Isabela.

Summary and Conclusions

Volcanic rocks of the Northern and Central Interior Highlands cover a large array of types of deposits. Included are lahars, nuée ardentes, lava flows, and other pyroclastic debris slides and flows. Their composition also varies from hornblende andesites to augite andesites, hornblende-biotite rhyodacites, iddingsite basalt, olivine basalts, and pyroxene andesites with accessories of magnetite, quartz, calcite, ore, hematite, and even goethite.

Even though more extensive research in the more inaccessible regions of the Highlands is not likely to be done, it is evident from what is now known that the Interior Highlands were once the center of a large amount of volcanic activity in the Tertiary and Quaternary periods and that the present line of volcanic activity is possibly only a younger brother of this older volcanic region.

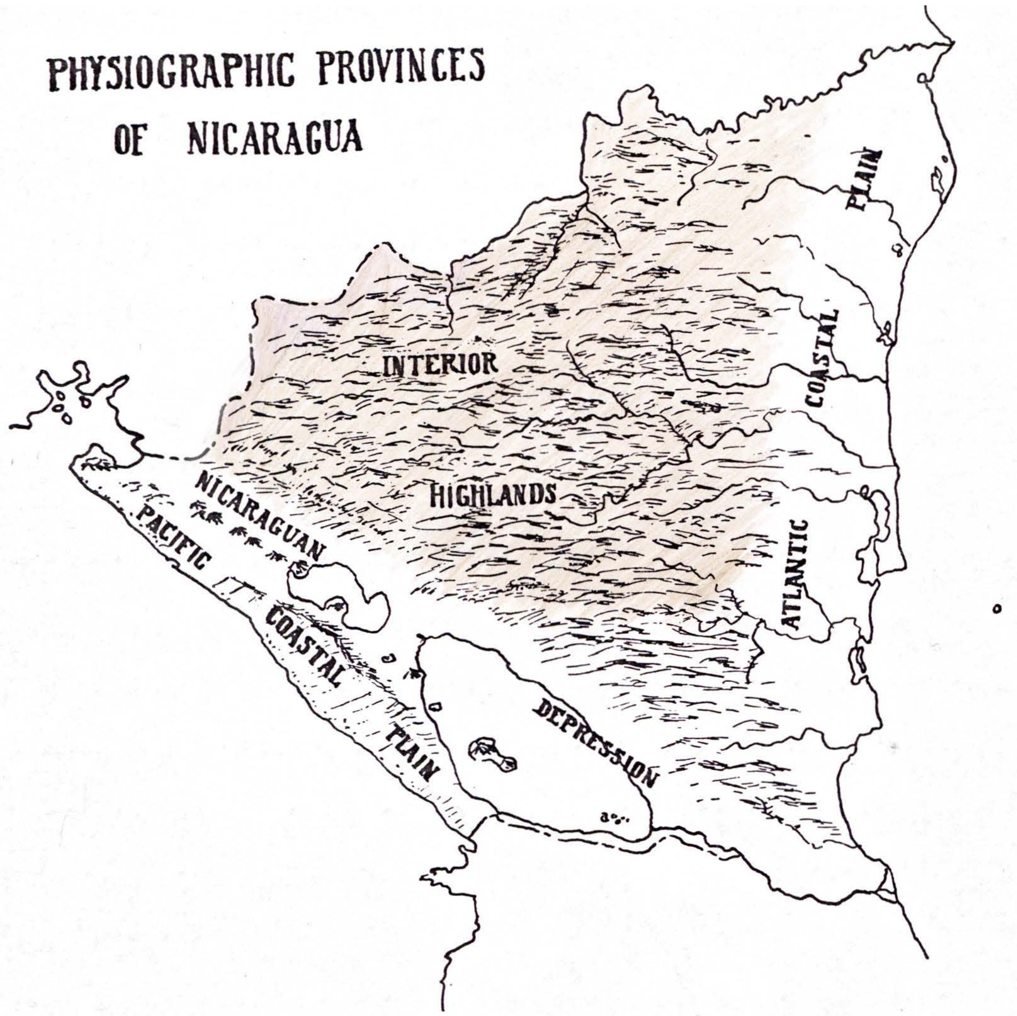
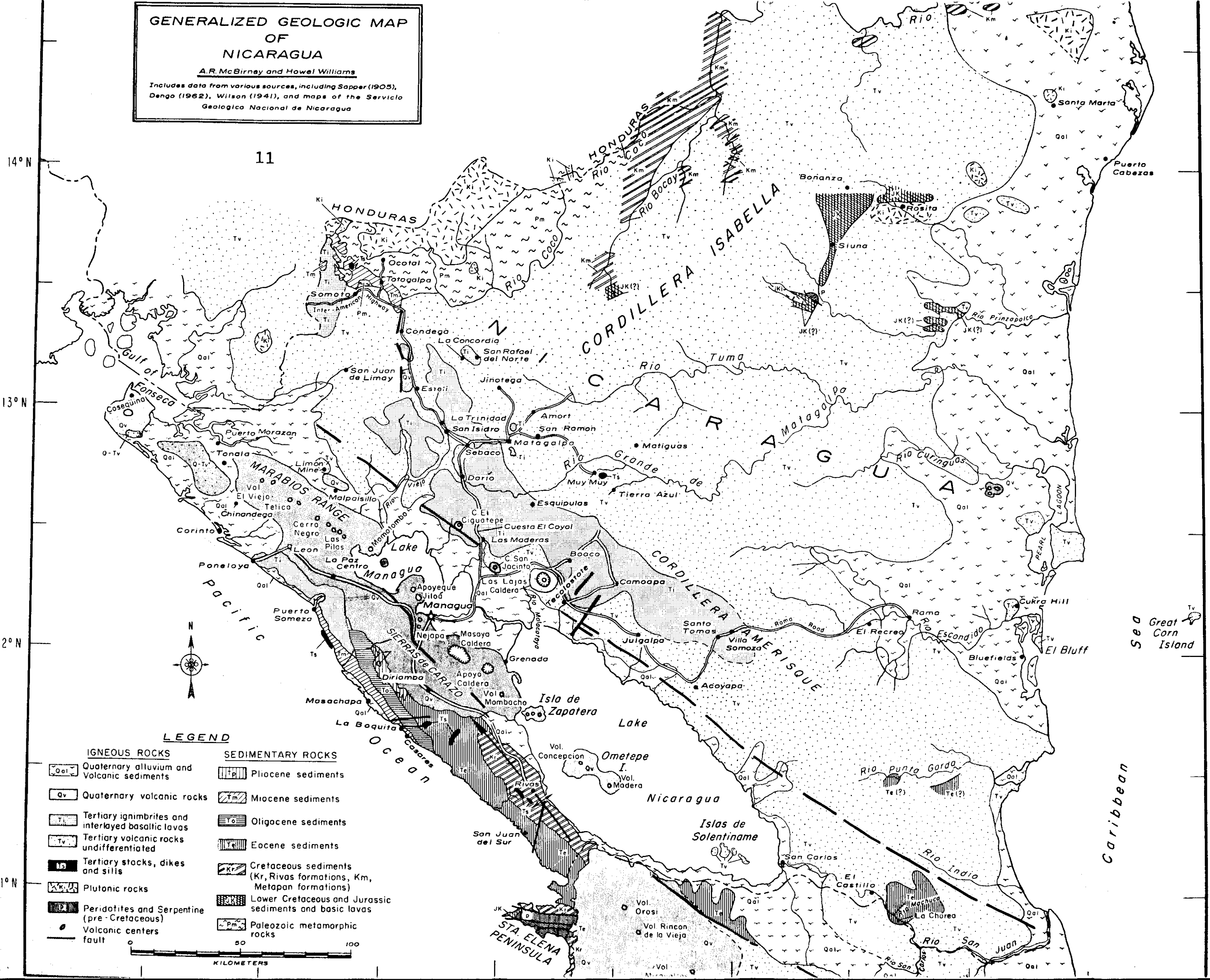
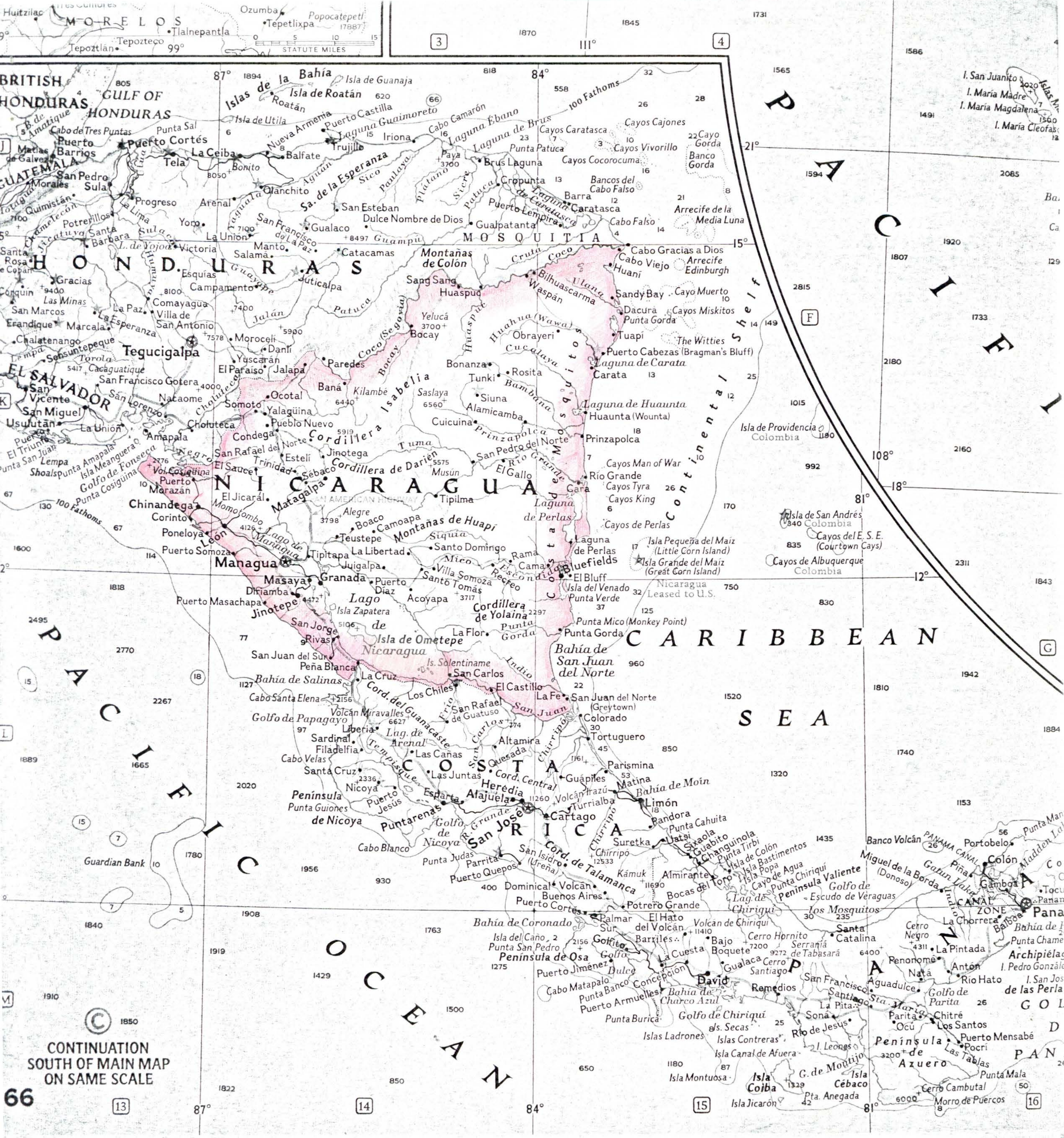


Fig. 1. Physiographic provinces of Nicaragua.

Northern and Central Interior Highlands


GENERALIZED GEOLOGIC MAP OF NICARAGUA
A. R. McBirney and Howel Williams
Includes data from various sources, including Sapper (1905), Dengo (1962), Wilson (1941), and maps of the Servicio Geologico Nacional de Nicaragua
11
14° N
13° N
12° N
11° N
LEGEND
IGNEOUS ROCKS
Quaternary alluvium and Volcanic sediments
Quaternary volcanic rocks
Tertiary ignimbrites and interlayed basaltic lavas
Tertiary volcanic rocks undifferentiated
Tertiary stocks, dikes and sills
Plutonic rocks
Peridotites and Serpentine (pre-Cretaceous)
Volcanic centers
fault
SEDIMENTARY ROCKS
Pliocene sediments
Miocene sediments
Oligocene sediments
Eocene sediments
Cretaceous sediments (Kr, Rivas formations, Km, Metapan formations)
Lower Cretaceous and Jurassic sediments and basic lavas
Paleozoic metamorphic rocks
0
50
100
KILOMETERS
N
HONDURAS
NICARAGUA
CORDILLERA ISABELLA
CORDILLERA AMERISQUE
MARABIOS RANGE
SIERRAS de CARAZO
Gulf of Fonseca
Pacific Ocean
Caribbean Sea
Lake Managua
Lake Nicaragua
Isla de Zapatera
Ometepe I.
Islas de Solentiname
Great Corn Island
STA. ELENA PENINSULA
Rio Coco
Rio Bocay
Rio Tuma
Rio Grande de Matagalpa
Rio Curinguas
Rio Prinzapolca
Rio Escondido
Rio Punta Gorda
Rio Indio
Rio San Juan
Rio Viejo
Rio Malacatoya
PEARL LAGOON
Inter-American Highway
Rama Road
Managua
Leon
Corinto
Poneloya
Chinandega
El Viejo
Tonala
Puerto Morazan
Coseguina
Somoto
Ocotal
Totogalpa
Condega
La Concordia
San Rafael del Norte
San Juan de Limay
Esteli
La Trinidad
San Isidro
Sebaco
Dario
Jinotega
Amort
San Ramon
Matagalpa
Matiguas
Muy Muy
Tierra Azul
Esquipulas
C. El Ciguatepe
Cuesta El Coyal
Las Maderas
C. San Jacinto
Las Lajas Caldera
Boaco
Tecolostote
Camoapa
Juigalpa
Santo Tomas
Villa Somoza
Acoyapa
El Recreo
Rama
Bluefields
El Bluff
Cukra Hill
Bonanza
Siuna
Rosita
Santa Marta
Puerto Cabezas
Telica
Cerro Negro
Las Pilas
La Paz Centro
Momotombo
Malpaisillo
Limon Mine
Apoyeque
Jiloa
Nejapa
Masaya Caldera
Apoyo Caldera
Vol. Mombacho
Grenada
Diriamba
Masachapa
La Boquita
Casares
Puerto Someza
Rivas
San Juan del Sur
Vol. Concepcion
Vol. Madera
San Carlos
El Castillo
La Chorea
Vol. Orosi
Vol. Rincon de la Vieja



Scale:

1: 4,942,080 or 78 miles to the inch

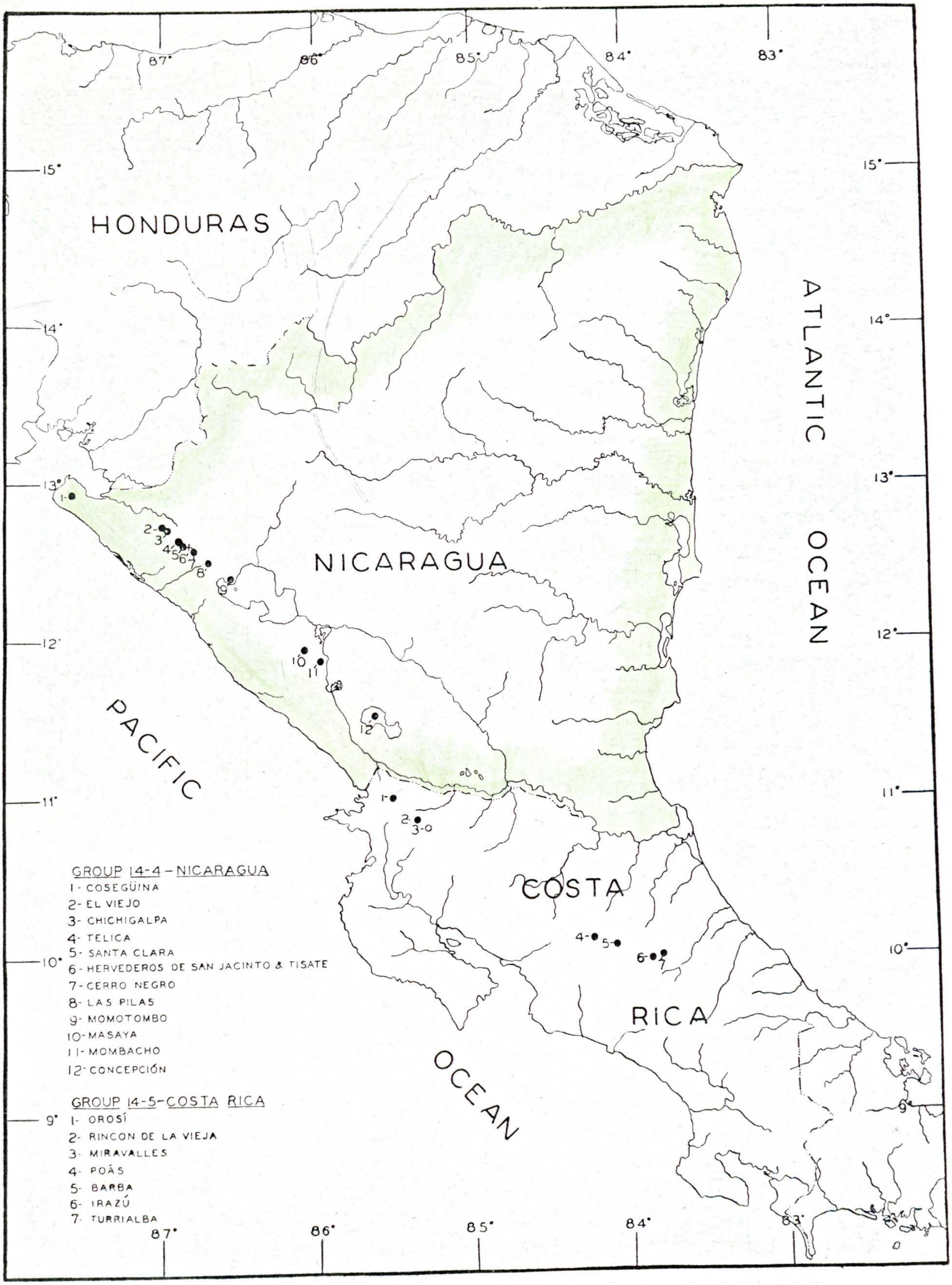
0 50 100 150 200 250 300

Statute miles

0 50 100 150 200 250 300

Kilometers

Geographic Map of Nicaragua



Index map showing the sites of the volcanic centres of Nicaragua and Costa Rica.

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